ADAPTIVE HARVEST MANAGEMENT WORKING GROUP

Tidewater Inn, Easton, Maryland
May 2-5, 2000

Purpose of Meeting

The purpose of this, the 12th meeting of the Adaptive Harvest Management (AHM) Working Group, was to review the status of adaptive harvest management for mallards, to seek improvements in the current AHM protocol to account for species and populations other than midcontinent mallards, and to consider ways in which AHM might be more responsive to the attitudes and desires of hunters.

Early Evolution of Adaptive Harvest Management For North American Waterfowl: Selective Pressures And Preadaptation *(Jim Nichols)*

State, provincial and federal agencies have devoted serious consideration and efforts to the management of North American waterfowl populations for much of the 20th century, yet an adaptive approach to waterfowl management was not actually implemented until 1995. Here, we discuss the evolution of adaptive harvest management for North American waterfowl in terms of factors and events that led to its adoption. The primary selective pressures involved stakeholder perceptions of waterfowl population status and management actions that were implemented conditional on population status. For example, there were frequent disagreements among stakeholders about appropriate management actions, and results of waterfowl research were frequently ambiguous and of little help in providing resolution. A number of aspects of waterfowl research and management can be viewed as preadaptations with respect to the adoption of AHM. For example, such preadaptations include the components necessary for implementation of AHM (or at least precursors of these components): management options (waterfowl researchers and managers were beginning to advocate simple, discrete sets of regulations rather than small changes that could be viewed as nearly continuous in space and time), model set (competing hypotheses had been developed to describe the translation of hunting mortality into changes in abundance), corresponding measures of model uncertainty (analyses of historical data provided information about the relative faith merited by these models), monitoring program (an integrated monitoring program has been fully operational since 1960, with components of the program existing since 1930), and an objective function (although sufficient attention had not been devoted to a clear statement of management objectives, certainly all stakeholders had views on objectives). From an evolutionary perspective, the selective pressures that led to the adoption of AHM are even more strong and compelling today than they were during the years of development of the AHM program. This historical review thus leads to the strong conclusion that the continuation and expansion (to other species, locations, and types of management actions) of adaptive management should be a primary focus of waterfowl management efforts during the next century.

Adaptive Harvest Management: Has Anything Really Changed? *(Dale D. Humburg, Thomas W. Aldrich, Scott Baker, Gary Costanzo, James H. Gammonley, Michael A. Johnson, Bryan Swift, and Dan Yparraguirre)*

Management of duck harvests has been among the more debated wildlife resource issues during the last 60 years. The controversy was particularly apparent during the 1980s as wetland habitat conditions and populations of ducks reached levels reminiscent of the 1930s. A desire for greater input into regulations by states, greater understanding of harvest impacts, increased hunting opportunity, and regulations simplicity were among the expectations of the flyways by the late 1980s (Babcock and Sparrowe 1989). An adaptive management approach to developing duck regulations (Johnson et al. 1993) is an information-based and explicit process to advance the credibility and integrity of duck harvest management. We evaluated harvest management progress in the context of expectations that have not changed (based on Babcock and Sparrowe 1989) and AHM, which has changed the nature of the debate.

Expectation: Regulations Based on Flyway or Subunit: The distribution of waterfowl, waterfowl hunters, harvest, hunting opportunity, wetland habitats, and the traditions and experience among hunters and waterfowl managers have never been equal within or among flyways. Thus, each state and flyway brings a unique and legitimate perspective to the regulations process. The dispute about "... a fair allocation of these shared resources" (Lewis 1989) has not changed. Adaptive Harvest Management provides an objective, data-based approach to developing regulations recommendations. The explicit nature of AHM has changed the technical process of developing regulations recommendations; however, there is a need to clearly separate the issue of deciding on the annual optimum level of harvest from the debate about how the harvest will be shared (Johnson and Williams 1999).

Expectation: Higher Duck Populations to Provide Greater Hunting Opportunity and Harvest: Objectives for waterfowl harvest management historically were implied but were never explicitly stated. The struggle during early development of AHM to clearly define the harvest management objective for midcontinent mallards (Anas platyrhynchos) led to an objective for maximum long-term harvest that is a product of numbers of hunters, their effort (days hunted), and success (bag per day) and is in the context of North American Waterfowl Management Plan (NAWMP) goal for midcontinent mallards. This objective captures the overall intent of harvest management but does not reflect the regional differences in the weight placed on hunting opportunity, success, and participation. Although an overall harvest objective is a clear improvement, the fundamental problem remains – how harvest and hunting opportunity are distributed. It will be increasingly important to understand how hunter satisfaction, hunting activity, and regulations are related if AHM is to provide complete insights into the effects of harvest management.

Expectation: Maintain Traditional Harvest Opportunities: The desire to provide maximum hunting opportunity in the face of changing population status and habitat conditions and the disagreement about harvest impacts on duck populations have been the bases for the historic conflict in duck harvest management. Traditional disagreements about the distribution of harvest and hunting opportunity were evident when AHM regulations packages were developed during 1995, revised in 1996-97, and adjusted to accommodate frameworks extensions in 1998 and 1999. Again, the explicit approach required under AHM resulted in discomfort among managers, largely because deliberations were based less on information and science and more on perception and historic differences in opinion. Undoubtedly, disagreements about regulations will remain, as evidenced by changes throughout the short history of AHM. Future debate about the regulations packages, however, must be the result of clearly stated intent if AHM is to progress.

Expectation: Greater Understanding of Harvest Impacts on Populations: Uncertainty and disagreement about the impacts of harvest and habitat conditions on duck populations always has influenced duck harvest management decisions. Modeling relationships among habitat conditions, reproduction, harvest, and population status as well as predictions about the influence of harvest and habitat on populations (Williams et al. 1996) was a prerequisite to AHM. As a result waterfowl managers and policy makers now share the same set of evolving models about the mallard life cycle and hypotheses about harvest and habitat influences. Questions remain about whether all essential environmental variables that affect mallard production or survival are included in AHM models (e.g., upland nesting conditions, wintering habitat, etc); however, AHM has provided a focus for improving the information needed to advance waterfowl harvest management.

Expectation: Greater Input into Harvest Regulations: The Flyway Council System, established a half-century ago, ensured the collective input of flyway states into migratory bird management (Jahn and Kabat 1984, Wagner 1995). The waterfowl harvest issues facing managers, however, are essentially unchanged in the 1990s. Little has changed in the administrative process of regulations development. The cycle of information gathering, state and flyway input, and federal frameworks recommendations have remained essentially unchanged for >20 years. Knowledge of the possible regulations recommendations and the method of developing the optimal harvest rate (Lubow 1995, Johnson 1997) provide a common basis for earlier and more explicit regulation development.

Expectation: Fully Justified and Easily Understood Regulations: Regulation simplicity was a theme when hunting regulations for migratory birds were reviewed (USDI 1988). Although not completely consistent with the intent of SEIS 88 for stabilized regulations, AHM has provided for more consistent expectations. Rather than stabilized regulations, AHM provides a stabilized process, and instead of more simple regulations, AHM at least provides fewer choices at an earlier time in the process. The information-based nature of AHM ensures that harvest management is technically sound (fully justified), yet, it is not necessarily easily understood. Adaptive Harvest Management is attractive at an intuitive level because of the requirement for explicit objectives, limited regulations options, and methods for how information will be used to update management strategies. The rigorous nature of optimization, system modeling, model updates, and information feedback, however, is not intuitive to most managers and policy makers. Confidence in the technical recommendations will only evolve as innovative approaches are applied and incremental improvement in harvest management occurs. The process of AHM should be an invitation for critical involvement, not a target for criticism.

The AHM process has developed during a period of improving habitat conditions and increasing numbers of ducks. Implementation of AHM almost has been "too easy" because there has been little bad news during this period of improved resource status. Thus, expectations for greater hunting opportunity also are linked to the timing of AHM. Our challenge is to inform waterfowl managers, policy makers, and hunters about the nature of population and habitat fluctuation so that the inevitable decline that is characteristic of ducks and wetlands is not perceived to be specifically due to AHM or to harvest regulations in general.

Conclusions: Adaptive Harvest Management has provided a forum for addressing the technical advancement of harvest management; however, lack of resolution of key "ethical definitions" will continue to characterize the ongoing controversy over regulations. Even if we discover exactly what impact harvest and habitat conditions has on duck populations, develop perfect knowledge of the impacts of regulations on harvest, understand the dynamics of hunter preferences, and measure all of these without error, disagreement about the nature of regulations likely will remain. Adaptive Harvest Management, however, can be a product of efforts to improve the science and apply the result.

What will harvest management and perhaps AHM look like in ten years? This will depend on 1) how we handle the next drought, 2) leadership in staying the course of AHM, 3) efforts by technicians and administrators to educate themselves about AHM, 4) resolution to the debate about how harvests are distributed and 5) consciously separating the allocation debate from the technical process of developing an optimal harvest strategy.

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Adaptive Regulation of Waterfowl Harvests: Lessons Learned and Prospects for the Future *(Fred A. Johnson and David J. Case)*

The system of waterfowl harvest management in North America is unparalleled among wildlife conservation programs in terms of scope, complexity, and cost. Moreover, the record of accomplishment has been impressive, especially when compared with more somber accounts of resource exploitation and collapse that tend to characterize natural resource development. For all of the success, however, great uncertainty persists about the impacts of hunting regulations on the biological and sociological systems of interest. In response to rising frustration over the regulations-setting process, the U.S. Fish and Wildlife Service adopted a framework of adaptive harvest management (AHM) in 1995. AHM is intended to provide effective decisions in the face of management uncertainties, as well as a systematic approach for reducing those uncertainties. Our goal in this paper is to examine what has been learned from our experience with AHM. We argue that most of those lessons have more to do with the nature and functioning of institutions than with biology and the impact of regulations. If AHM is to remain a viable process for coping with management uncertainties, managers must be willing to recognize and accept the constraints exposed by the process. It has become clear that much of the traditional perception of system control is misguided, and that there are discernible limits to both short-term harvest returns and the learning needed to increase long-term performance. Managers also must learn to draw a better distinction between objective science and subjective goal setting. Too often, managers associate themselves with particular combinations of management goals and beliefs about resource dynamics. The resulting coalitions tend to talk past each other, unable to clearly differentiate areas of agreement and disagreement, nor develop a shared perception of a controversial issue. Overcoming these institutional problems will require a difficult process of self-examination and behavior modification. Ultimately, we will consider AHM an unqualified success if it motivates and guides this institutional renewal.

Flyway Status Reports

Pacific Flyway: Don Kraege from Washington State has officially replaced Jeff Herbert as one of the Pacific Flyway representatives to the AHM Working Group. The Pacific Flyway Study Committee and Council remain supportive of AHM. At their March meeting, the Pacific Flyway Council re-iterated its support for the continuation of existing frameworks and its concern that the framework debate detracts from the technical effort to improve the harvest management of stocks of ducks important in the Pacific Flyway.

As part of the western-waterfowl survey initiative, the Pacific Flyway conducted an experimental breeding-pair survey in central British Columbia to assess mallard breeding densities there. British Columbia is believed to be a significant source of western mallards, and almost all of the province is excluded from existing USFWS-CWS surveys. Breeding population survey transects were flown with a helicopter in 1999, and data were analyzed using standard USFWS-CWS protocols. Results also were referenced to wetland types, for comparison to existing habitat databases and surveys maintained by the CWS. Preliminary indications are that up to 500,000 mallards breed in areas of British Columbia not covered by USFWS-CWS surveys. Experimental surveys are planned again for this spring.

There continues to be interest in the Study Committee to increase their understanding of the population models and the adaptive dynamic optimization process. The Pacific Flyway remains committed to developing and improving model and data sets for western mallards and northern pintails. Flyway states have supported AHM since its inception, with the understanding that the system will be refined to accommodate pintails and multiple stocks of mallards. However, more work is needed to communicate both within the Study Committee and Council what the effects and costs are likely to be when managing the harvest of multiple stocks of ducks under AHM. Furthermore, the Study Committee believes that stabilization of packages is necessary to assist in increased learning about population dynamics.

Increased understanding of the process and communication remain important needs in the Pacific Flyway, and will increase as other stocks of ducks are included in AHM. We believe that most hunters in the Pacific Flyway will not actively engage in the process until more restrictive regulations are prescribed.

Central Flyway: The Central Flyway (CF) continues to support on-going AHM efforts. We believe that the following issues need to be addressed as AHM continues.

Although the Service has indicated that periods of stable AHM packages (3-5 years) are desirable, various states and flyways are continually interested in making changes to packages. Additionally, it is unclear how this stability (and the length of stable periods) will be affected by incorporation of other changes to the AHM approach (e.g., integration of eastern and western mallards, changes in underlying models). Because political pressure to change regulatory packages will always exist, we believe that the Service and Flyways can and should take proactive steps to address these desires for changes, while at the same time encouraging periods of stability in regulations. We suggest that the Service work with the Flyways to establish an advance schedule for reconsideration of AHM packages. For example, if packages were to be changed for the 2000-2001 season, the Service could then endorse and facilitate another reconsideration of packages for the 2004-2005 season. This would give the states more definitive "targets" for dealing with desires to change regulations (similar to the approach used to address criteria for zones and splits). It would also ease fears that the preferred approach will always be to maintain existing regulations indefinitely in order to avoid the technical challenges of addressing legitimate desires for change.

When AHM packages are reconsidered, the CF believes that efforts should be made to directly address issues of harvest allocation. While the Service and many states earlier endorsed the idea of "maintaining traditional flyway differences" when developing AHM packages, these historical relationships between and within flyways are clearly at the heart of much of the dissatisfaction with current AHM packages. Given that eastern and western populations of mallards are being incorporated into AHM, and that objective functions center on overall population sizes and harvest levels, we believe that requiring traditional among-flyway relationships in season length to be maintained is unnecessary and overly constraining. We note this point applies equally to relationship between regulations among all flyways, including between the CF and Mississippi Flyway.

AHM approaches designed for mallards place constraints on our ability to manage harvests of other species, and our ability to monitor populations of many other species is limited relative to mallards. Variable bag-limit restrictions exist for a number of species, adding to the complexity of regulations. The CF encourages attempts to more closely monitor effects of AHM packages on population sizes and harvests of other duck species. We also believe that changes in harvest rates of female mallards resulting from increases in the bag limit, and potential effects of higher hen harvest on AHM models and optimization procedures, should be carefully monitored.

Measures of harvest rates derived from banding information are key to the AHM process. The CF remains deeply concerned about all aspects of the administration of bands and banding data. Problems with reporting bands, accurately recording banding information, band availability, and band quality are becoming common. These basic problems may impact efforts to measure current band reporting rates through reward band efforts. We encourage the Service and all flyways to continue to make these banding concerns high profile, high-priority issues. In addition, the CF would like more information on current efforts to determine band-reporting rates, and plans for future efforts.

The CF is encouraged by efforts to improve the underlying models and model updating procedures used in AHM. We would like more information on progress in these efforts, the expected timing of changes to models and databases, and measures of improvement in model performance.

The integration of AHM approaches for multiple stocks will be an important challenge. As AHM approaches for eastern mallards, western mallards, and pintails are finalized, decisions will need to be made and agreed to by the Flyway Councils regarding how to best combine these approaches. Until recently, it seemed that a major limitation on integrating AHM for multiple stocks was computer capabilities. As advances in hardware and software capabilities continue, the states will need effective communication of the various options for integrating multiple stocks, and especially the potential effects on the outcomes of optimization procedures that result from different options.

The CF believes that long-term support for AHM depends strongly on effective communications, both internally and externally. We appreciated Fred Johnson's involvement in our December 1999 winter technical committee meeting to discuss AHM topics, and we also value the continued involvement of Jim Dubovsky with the CF. As the complexity of AHM approaches increase, we believe it will be even more important to communicate both technical and non-technical aspects of AHM to the flyways. Of particular importance is communication of any progress made in our understanding of the effects of harvest on populations and the ability to manage duck harvests.

In keeping with ideas discussed at last year's AHM Working Group meeting, and the efforts of Dale Humburg and others, the CF supports efforts to learn more about the charcteristics of the hunting public and factors that influence hunter recruitment, participation and satisfaction. Although a national-level hunter survey is intuitively appealing, we believe it will be difficult to design and implement a survey that accurately measures the thoughts and desires of waterfowl hunters from broad geographic areas and widely divergent backgrounds, traditions, hunting methods, hunting opportunities, etc. We believe this important area of inquiry will require much additional discussion and planning to achieve well-defined objectives.

Finally, the CF supports and encourages greater involvement by Canada in adaptive management approaches to duck harvests. Close coordination between the U.S. and Canada is integral to long-term management of North American duck populations. Canadian members of the flyways are strongly involved in the monitoring efforts used in AHM, and we encourage their greater participation in regulatory approaches, as well.

Mississippi Flyway: Primary duck harvest management issues considered by the flyway during 1999-2000 included concerns about the regulations alternatives, emphasis on species-specific harvest management, and information about hunter activity and attitudes. The 3 aspects related to AHM regulations alternatives were 1) clarification of the blank cells in the decision matrix, 2) utility of the "very restrictive" option (20 days in the Mississippi Flyway), and 3) the nature of annual changes in regulations.

A systematic process for informing future management decisions was considered to incorporate measures of hunter preference and satisfaction into waterfowl harvest management. A subcommittee within the AHM Working Group was charged with initial scoping of feasibility. In this regard, a survey of states in the 4 flyways was conducted to determine interest and concerns.

Proposals for greater harvest-management emphasis for duck stocks other than midcontinent mallards prompted questions about the propriety and potential of a more refined management scale. Workshops were conducted to encourage discussion about the implications of more species-specific management.

Each of the above issues was presented and discussed during this meeting. Abstracts of these presentations & discussions are included elsewhere in this summary.

Atlantic Flyway: *Integration of Eastern Mallards*--From the inception of this working group, the Atlantic Flyway's primary goal has been the development of harvest strategies based on the status of eastern duck populations, rather than midcontinent breeding birds. Fred Johnson estimated that eastern mallards may be able to sustain liberal seasons 98% of the time (compared to 64% of the time for midcontinent birds). Having almost constant "liberal" seasons would be of great benefit to our hunters and would simplify our efforts as managers and administrators.

We very much appreciate the recent technical assessment prepared by Fred Johnson, Diane Eggeman, Jim Dubovsky, and Mary Moore. We were especially pleased that a complex integration of eastern and midcontinent mallards does not appear necessary for determining regulations in the Atlantic Flyway. Because eastern mallards comprise such a large proportion of our harvest, accounting for the status of midcontinent mallards has virtually no effect on our harvest strategy. Consequently, we recommended that duck hunting regulations for 2000-01 in the Atlantic Flyway be based solely on the optimal strategy for eastern mallards. After nearly a decade developing databases on eastern mallards, we look forward to this new approach.

Within the flyway, the proportion of eastern mallards in the harvest varies from 100% in New England to about 50% in the south, so some states are concerned that they may over harvest midcontinent birds that winter in the south. In time, we may need to consider whether we should develop a mixed stock strategy for the southernmost states.

Satisfaction with Current Regulatory Alternatives--The Atlantic Flyway Council recommended that the regulatory alternatives for this year be the same as those used in 1999. These are the same 4 "packages" of season length, duck bag limits, and framework dates that we have used since 1997. Most states appreciate the additional recreation and harvest opportunity afforded by the current options (especially longer seasons and the 2-hen mallard limit), compared to the packages used previously. In fact, no one has expressed a desire for longer seasons or higher bag limits for total ducks than we have in the current liberal option.

Although we recommended no changes in regulatory packages this year, there are some concerns, and possible changes desired, to increase hunter satisfaction and address potential harvest concerns for stocks other than eastern mallards, especially if the liberal alternative is selected every year.

Foremost is the desire among some southern states for framework-date extensions like certain Mississippi Flyway states have been offered in recent years. Several states have indicated that they would accept a reduced season length if necessary to offset any additional harvest resulting from season extensions to January 31. However, any compensation or adjustment in season length should be state by state, not flyway wide. Although this would complicate prediction of harvest rates, most states in the Atlantic Flyway would vigorously oppose any across-the-board loss of opportunity to accommodate season extensions in a few states. We are very concerned about the potential for reduced frequency of liberal seasons as a result of framework extensions.

There is also some concern that the current season length (60 days) may result in over-harvest of species other than mallards, although population trends have not indicated any problems to date. And there are concerns about the 6-duck bag limit, for social as much as biological reasons. Most biologists would prefer the total duck limit to be the same as the mallard limit, as we recommended back in 1997. It is hard for many to accept higher bag limits for diving ducks, since any additional harvest, although small, is not desirable. Most of the concerns expressed to date have been for more conservative regulations.

To address these concerns, we recommended that the current regulatory options be reviewed during the coming year and any desired changes be proposed for flyway consideration by winter 2001. This will require considerable work by our Technical Section to reach consensus on any desired changes. It will also require analysis by USFWS to predict mallard harvest rates for any new alternatives. The amount of technical work required will depend on the magnitude of any changes we propose. We did not develop a detailed plan for this review, but plan to begin brainstorming possible changes at the summer meeting. Assuming that Atlantic Flyway regulations will be set independent of other flyways, we should not have to get formal approval from the other flyways. Nonetheless, we want to advise everyone via the AHM Working Group that we will be considering possible changes in the packages for the 2001-02 season.

National Duck Hunter Survey--We talked about the need for duck hunter surveys in the Atlantic Flyway. The AHM Working Group requested input on specific objectives or information needs of a national survey. It seems that the survey would focus on hunter satisfaction with the current regulatory alternatives as a principal objective. Flyway biologists had mixed opinions about the need for such a survey and several questioned our ability to ask questions that would provide useful information for the desired review of regulatory alternatives. Consequently, there was no consensus or commitment by the flyway to participate in a coordinated national duck hunter survey at this time. Some states would be willing to participate, and others may join in if the purpose and benefits are more clearly defined.

AHM for Other Species--We are pleased with the development of eastern mallard harvest strategies, but we must now consider possible implications of that harvest strategy (i.e., nearly constant 60-day seasons) for other species in the Atlantic Flyway. In the coming year, we plan to participate in efforts to determine whether databases are adequate to apply AHM to black ducks and wood ducks. We are much less interested in AHM for pintails since they account for only 1.3% of our total duck harvest, and we may harvest a sub-population of "eastern" pintails that is not currently recognized. Canvasbacks already have been explored without success, and scaup may have similar problems with adequacy of data. Realistically, we should explore AHM only for species that account for a large proportion of the harvest and have extensive databases. Prescriptive approaches will have to be used for other species even if harvest may be more conservative than necessary.

Outlook for Breeding Ducks in 2000 *(Jim Wortham)*

On average, habitat conditions across North America for breeding waterfowl could be considered fair to good. In Prairie Canada, precipitation amounts since September of 1999 have been below average in southeastern portions of Alberta, but average or slightly above average across the remainder of the Prairie Provinces. However, temperatures since the beginning of the year have ranged from near average in central Alberta, to slightly above average in Saskatchewan, to temperatures reaching 5º C above average in Manitoba. As a result, there are drought conditions in north-central and western Alberta, normal conditions in Saskatchewan, and slightly better-than-normal conditions in southeast Manitoba. However, these conditions may be overly optimistic given the decreased opportunity for recharge from snow runoff in the mountains.

In the north-central States, precipitation amounts since the fall of 1999 have remained below average, while temperatures have been 5º F above average across the prairies and the Midwest. These conditions have resulted in drought conditions in the eastern prairies of North and South Dakota and the upper Midwest. Vegetative condition across this region is not as favorable as last year, with decreased chlorophyll and moisture signatures indicating some vegetation stress across the area.

In the eastern provinces of Ontario and Quebec, conditions are slightly improved from last year, with good water conditons and favorable vegetative conditions throughout. The timing of spring conditions across the region were judged to be normal, while spring conditions in the Maritimes appeared one to two weeks earlier than normal.

Communications Update *(Dave Case)*

Dave Case reviewed the goal and objectives from the 1999 communications strategy with the group:

Goal: All interests involved in the waterfowl regulations-setting process support AHM as the long-term process by which waterfowl hunting regulations should be set.

Objectives: The objectives of the communications strategy are that all target audiences:

Know

* what AHM is, why it was needed, and how it improves on the regulations-setting process used prior to the 1995-96 seasons
* AHM has been developed cooperatively between the States, Flyway Councils, USFWS, and waterfowl hunters

Feel

* comfortable that the AHM process is scientifically rigorous and carefully balances hunting opportunity with long-term waterfowl conservation
* excited about the positive results for waterfowl conservation from AHM

Do

* support AHM as the process by which waterfowl hunting regulations should be set, even when the regulatory choice may seem inappropriate

Dave commented that he felt these objectives had largely been achieved to date as pointed out by both Fred Johnson and Jon Andrew in their opening comments. Although there are, and will continue to be, ongoing communications needs, the Working Group should recognize what they have accomplished through their communications efforts. In general, the group agreed that the goal and objectives were still valid.

The group then reviewed the priority communications "issues/considerations" from the 1999 communications strategy:

Issues/Considerations: The following list of issues and considerations (in priority order) are the foundation of the communications strategy:

(1) widening gap in expertise and understanding on technical issues (statistics, modeling, etc.) between various internal audiences–even biologists;

(2) building expectations among hunters/others that things will change and how–hunting variability;

(3) some unrealistic expectations of AHM among Flyway technical committees and Councils;

(4) how ducks other than mallards will be accommodated in AHM;

(5) the need for rigorous, systematically-gathered information on hunter preferences and satisfaction;

(6) allocation of harvest opportunity with and among flyways;

(7) meaning of the blank cells in the decision matrix;

(8) need to emphasize the long-term benefits of AHM–keep a long-term perspective;

(9) States not taking the full frameworks/bags for mallards;

(10) individuals on the AHM Working Group are critical to an effective communications effort and must play an aggressive, active role;

(11) when populations decline, especially if they decline significantly, external communications will become more important and more difficult;

(12) general lack of understanding among many audiences of the regulatory process overall, natural fluctuations in duck populations in North America, and the uncertainty involved in managing waterfowl populations;

(13) need to communicate "results" from the first years of implementation.

The group discussed this list and made the following modifications:

- emphasize that we can't keep changing the packages;
- point out the relative importance of harvest versus recruitment; and
- what AHM is and is not–need to continually clarify this.

The Working Group asked that the communications team come back with a report at the end of the meeting. The team should discuss the list of technical priorities the Working Group discussed and provide recommendations on how to address these technical issues with communications.

Optimal Harvest and the Importance of Model Form *(Mike Runge)*

Optimal control theory is finding increased application in both theoretical and applied ecology, and is a central element of adaptive resource management. One of the steps in an adaptive management process is to develop alternative models of system dynamics, models that are all reasonable in light of available data, but that differ substantially in their implications for optimal control of the resource. We explored how the form of the recruitment and survival functions in a general population model for ducks affected the patterns in the optimal harvest strategy, using a combination of analytical, numerical, and simulation techniques. We compared four relationships between recruitment and population density (linear, exponential, hyperbolic, and power); and four relationships between survival during the non-harvest season and population density (constant, exponential, logistic, and one related to the compensatory harvest mortality hypothesis). We found that the form of the component functions had a dramatic influence on the optimal harvest strategy and the ultimate equilibrium state of the system. For instance, while it is commonly assumed that a compensatory hypothesis leads to higher optimal harvest rates than an additive hypothesis, we found this to depend on the form of the recruitment function, in part because of differences in the optimal steady-state population density. This work has strong, direct consequences for those developing alternative models to describe harvested systems, but is relevant to a larger class of problems applying optimal control at the population level. Often, different functional forms will not be statistically distinguishable in the range of the data. Nevertheless, differences between the functions outside the range of the data can have an important impact on the optimal harvest strategy. Thus, development of alternative models by identifying a single functional form, then choosing different parameter combinations from extremes on the likelihood profile may end up producing alternatives that do not differ as much as if different functional forms had been used. We recommend that biological knowledge be used to bracket a range of possible functional forms, and robustness of conclusions be checked over this range.

Population Modeling for Wood Ducks *(Khristi Wilkins)*

We are developing a wood duck population model to help guide harvest management of this species. While there are no obvious biological controversies (e.g., additive vs. compensatory mortality; density-dependent vs. density-independent recruitment), we do have a variety of management and technical issues to consider when developing a model of wood duck population dynamics. Relevant management issues include interest in increased hunting opportunity in some States, and concern for over-harvest of local populations in others. Two important technical issues affecting wood duck modeling efforts are that we have no estimates of population size, and crippling-loss and band-reporting rates are unknown. The model will be used to assess the effects of harvest mortality on wood duck population dynamics. Sensitivity analyses and simulation will be used to assess model dynamics. Specifically, given the current constraints, the model will be used to assess the risk to wood duck populations posed by increasing harvest opportunity; either by increasing the daily bag limit from 2 to 3 flyway-wide or by the establishment of a special season prior to the regular season. If other management options become of interest to the Flyways, the model can be used to evaluate the impact of these options (assuming, of course, that the effect of regulations on harvest can be predicted). In the future, this model can also form the basis of any adaptive management effort involving joint optimization of wood ducks, black ducks, and eastern mallards.

Our model will be similar to the model developed by Mike Conroy et al., for black ducks, with 2 age cohorts and annual reproduction: $B(t+1) = B(t)S(t) + B(t)A(t)S'(t)$ where B=BBS index, S= annual survival of adults, S'= annual survival of young, and A= harvest age ratio. Annual survival will be further broken down into its component parts: survival during the hunting season and survival during the rest of the year. For estimates of reporting rate, we will use the mallard reporting rate adjusted by a correction factor (-7 to -8%) estimated from hunter-survey data. Sensitivity analyses will be performed on reporting and crippling-loss rates. If the model is sensitive to either of these parameters, we will include multiple models in our final model set. Survival modeling will be done at the reference unit level, as described in the wood duck monitoring initiative report. Reproduction may also be modeled at this level. Sex-specific differences will also have to be accounted for in survival modeling. However, all models will be combined into a flyway-level model for management purposes, because this is the appropriate scale of management as determined by the results of the wood duck monitoring initiative.

AHM Models for Eastern Mallards *(Diane Eggeman, Fred Johnson, and Jim Dubovsky)*

We examined reproduction and mortality in eastern mallards and developed a set of eight models describing the annual life cycle. We explored the implications of these competing models for predicting sustainable harvests. The models are based on differences in the functional form of the relationship between dependent and independent variables of interest. Two reproductive submodels express fall age ratios of males as either a negative-exponential or a logistic function of a Breeding Bird Survey (BBS) index. To enable managers to use current estimates of population size rather than the BBS index as the criterion for regulatory decisions, we expressed the BBS index as either a logarithmic or an exponential function of the population size estimated from recent aerial surveys. We developed two alternative submodels for survival, both of which include constant summer survival for males. However, one model allows random variation in summer survival of females, and the other expresses summer survival for females as a logistic function of the BBS index. We examined optimal harvest strategies and model behavior, relative to a management objective to maximize long-term cumulative harvest, using the eight alternative life-cycle models (2 reproductive models x 2 BBS models x 2 survival models). Optimal harvest rates tended to increase with increasing population size, although the increase was not monotonic for all models. For recent population sizes, seven of the eight alternative life-cycle models prescribed optimal harvest rates higher than those attained under current liberal regulations. We discuss implications of these results for management of other stocks of eastern ducks.

AHM for Midcontinent and Eastern Mallards *(Fred Johnson, Jim Dubovsky, Mary Moore, and Diane Eggeman)*

Modification of the current AHM protocol for midcontinent mallards to account for the status and dynamics of eastern mallards involves:

(1) revision of the objective function to account for harvest-management goals for eastern mallards;
(2) augmentation of the decision criteria to include population and environmental variables relevant to eastern mallards; and
(3) modification of the decision rules to allow Flyway-specific regulatory choices.

Based on our investigation of potential levels of stratification for harvest areas (i.e., the number of Flyway-specific regulatory choices), we believe there is sufficient justification for allowing a regulatory choice in the Atlantic Flyway that can differ from that in the remainder of the country. However, there seems to be little additional benefit (in terms of harvest) from allowing different rates of harvest in the Atlantic Flyway, Mississippi Flyway, and the remainder of the country, in spite of the considerable difference in the proportion of eastern mallards migrating to the Mississippi Flyway and the western two Flyways (13% vs. 0.05%, respectively). Moreover, when we permitted different harvest rates in the Mississippi and Central/Pacific Flyways, the pattern of differences in Flyway-specific harvest rates was not always intuitive and, consequently, raised questions regarding the most appropriate allocation of harvest opportunity between the Mississippi Flyway and the remainder of the country. The allocation of sustainable harvests (within that allowed by biological constraints) is a value judgement, and would require considerable inter-Flyway dialogue before a broadly accepted harvest strategy could be derived.

The patterns in predicted harvest rates associated with the 25 combinations of regulations in the Atlantic Flyway and the remainder of the country are consistent with what we know about the wintering distributions of midcontinent and eastern mallards. However, we emphasize that these predictions represent extrapolation beyond our range of experience. Moreover, the estimation procedure relies heavily on statistical and conceptual models that must meet certain assumptions. We have no way to verify these assumptions, nor can we gauge their effects should they not be met. Therefore, the use of this procedure for predicting mallard harvest rates warrants considerable caution and underscores the need to accumulate experience with a stable set of regulatory alternatives.

We were surprised that management performance (in terms of expected population sizes and harvest) was not sensitive to the form of the aggregate objective function. However, the result seems to follow from the high degree of spatial segregation of the two mallard populations during the hunting season. Therefore, an unweighted sum of population-specific harvest utilities seems to us a reasonable choice. However, we emphasize that in many, if not most, cases of managing multiple stocks the form of the aggregate objective function will be critical. Difficult value judgements will be necessary where populations vary markedly in abundance and capacity to support harvest, and where there is limited ability to regulate population-specific harvest rates.

Our technical efforts to account for eastern mallards in the current AHM protocol appear to have substantial policy implications. In particular, there seems to be no influence of midcontinent mallard status on Atlantic Flyway regulatory prescriptions, nor does there seem to be any significant impact of eastern mallard status on regulations in the remainder of the country (at least within the range of population sizes we examined). Therefore, the additional benefit (in terms of harvest opportunity and the NAWMP goal for midcontinent mallards) of integration appears to be negligible. However, the computational costs associated with derivation of the optimal harvest strategy for midcontinent and eastern mallards is considerable. We experienced severe limitations in our ability to fully explore the implications of all sources of uncertainty, for all possible system states, even when using state-of-the-art Pentium workstations. Therefore, we suggest that it may be more productive to integrate the harvests of eastern mallards with those of other key species in the Atlantic Flyway, rather than with midcontinent mallards. In effect, we suggest that the management community consider allowing the regulatory decision in the western three Flyways to be determined solely by the status of midcontinent mallards, and the decision in the Atlantic Flyway to be determined solely by the status of eastern mallards. We emphasize that these analyses and recommendations are based solely on an assessment of mallards, and that harvest impacts on other species always must be considered in the setting of hunting regulations.

AHM for Pintails: Progress and Pitfalls *(Mike Runge and Sue Sheaffer)*

The draft model set for pintails that was discussed last year required some modification, as a result of recent scrutiny and some insights about the importance of function form. In particular, the concern that the reproductive dynamics have changed over time is acute for pintails, because of the large-scale landscape changes that have occurred on the breeding grounds. To capture this in the model set, two alternative models for recruitment have been proposed: one (the "1961 model") that reflects a strong effect of average latitude of the breeding population, and one (the "1997 model") that reflects only a small effect of latitude. The idea is that degradation of the breeding habitat in southern Alberta and Saskatchewan because of conversion to agricultural land has reduced the productivity of pintails in this region to levels closer to the productivity in the northern areas of the breeding range. Two survival models ("additive" and "compensatory") were retained.

Equilibrium and state-dependent dynamics were calculated for the four resultant models. Profound differences in the optimal management policies were found. Under the "1961" recruitment model, the average latitude of the breeding population has a very strong effect on the optimal harvest rate, whereas the optimal harvest rate is relatively insensitive to latitude under the "1997" reproductive model. As expected, the "additive" and "compensatory" survival models produce large differences in the optimal harvest policy. For a fixed average latitude of the breeding population at or north of the historical mean (54.7/ N), the optimal equilibrium population size is below the NAWMP goal (5.8 million). Thus, using a utility function that discounts harvest when the projected population size is below the North American goal (similar to what is currently used for mid-continent mallards) results in a more conservative harvest policy.

A number of challenges have been identified in the course of recent work on pintail harvest optimization:

(1) The observed adjusted age-ratios, annual survival rates, and breeding population estimates do not match up well with each other. That is, when a simple balance equation (with few assumptions and little model detail) is used to predict breeding population size in year t+1 from breeding population size, age-ratio, and survival estimates in year t, the predictions are consistently higher than the observed breeding population size in year t+1. We believe this over-prediction is a very serious problem for the application of optimization. Ascertaining the reason for this over-prediction is a high priority. It is worth noting that a similar problem (though not of the same magnitude) is seen with mid-continent and eastern mallards, as well as other stocks.

(2) The system model used for the optimization analysis has two state variables: the breeding population size and the average latitude of the breeding population, but the breeding population is not broken down by sex. This means that a constant sex ratio in the breeding population size has to be assumed. Because information about the sex ratio is not carried in the state variables, the models will not be able to track changes in the sex ratio and the resultant change in dynamics. Optimization results indicate that the assumed fixed value for the sex ratio has a large influence on the absolute harvest, but a smaller influence on the optimal harvest rates.

More work needs to go into study of the impact of assuming a fixed sex ratio, the possibility of having two state variables for population size (males and females), and the estimation of sex ratio. Again, this issue applies to other duck stocks as well.

(3) There is a strong statistical negative correlation between the estimated breeding population size and the average latitude of the breeding population, a correlation that cannot be explained by time-series effects. This might be explained by several factors: there might be a negative bias in aerial survey counts of pintails at higher latitudes, and/or when the pintails breed farther north, there may be areas of the breeding ground that are not covered by the surveys (i.e., Siberia and southern Alaska). This monitoring issue needs to be studied before AHM for pintail can be confidently implemented.

In addition to the challenges noted above, a number of other aspects of the pintail model need to be examined before AHM can be implemented:

(1) An explicitly density-dependent survival model, instead of the phenomenological compensatory model, should be explored.

(2) The relationship between harvest-regulations packages and harvest rates, conditional upon the national mallard season length, needs to be estimated.

(3) The model set needs to be examined critically (i.e., does it capture the most important structural uncertainties?);

(4) At this point, there seems to be some consensus that the objective function would be to maximize long-term harvest subject to some discounting of harvest when the population falls below the NAWMP goal. The suitability of this objective function, especially given that the optimal equilibrium population size might be below this goal, needs to be discussed.

(5) The Pacific Flyway has expressed a preference for making the regulatory prescriptions for pintails conditional on mallard season length (as opposed to considering a season-within-a-season for pintails, or pursuing joint optimization of mallards and pintails). This induces a constraint to the optimal management of pintails. The effects of this in an AHM framework need to be explored, and this issue needs to be discussed further.

In summary, considerable progress has been made in the last year bringing together the pieces that would allow adaptive harvest management for pintails, but there remains much work to be done and several challenges to surmount. We are optimistic that these details can be worked out. At this point, we wish to finalize the model set at the Flyway technical committee level by January 2001, with review by the AHM technical committee in April 2001, and approval by the Councils in July 2001. The earliest that AHM for pintails could be implemented is July 2002.

AHM for Black Ducks *(Mike Conroy, Christopher Fonnesbeck, and Nathan Zimpfer)*

We reviewed progress to date on analysis and modeling of American black duck (*Anas rubripes*) populations, and described how this work has set the stage for the consideration of AHM as a tool for the development of international harvest strategies for this species. Most of the controversy surrounding causes for decline in black duck stocks relates to disagreement about the relative importance of harvest compared to other factors, notable expansion of mallard (*Anas platyrhynchos*) populations into the black duck range. We have developed and parameterized a model set that includes combinations of assumptions about compensation (no compensation vs. strong compensation via density-dependence mortality) and interference from mallards (no effect vs. negative effects on reproduction and survival of black ducks proportional to population density of mallards). This model set has been incorporated into a preliminary optimization model, which will be used to develop and compare scenarios under which AHM might occur for black ducks. Improvements of this model will include: (1) re-estimation of key parameters using recent population survey, harvest, and banding data; (2) a shift to an expression of key system states (black duck and mallard abundance) from winter surveys to spring surveys of breeding populations; and (3) development of models incorporating multiple breeding stocks in order to capture regional differences in habitat conditions, black duck densities, and the abundances and rates of increase of mallard populations.

Considerations for Species-specific AHM *(Dale Humburg)*

Proposals for greater emphasis on harvest management of duck stocks other than midcontinent mallards prompted questions about the propriety and potential of more refined management scale. There is a clear need to understand and communicate the implications of an “AHM approach” for species other than mallards so that expectations are realistic. Mississippi Flyway Technical Section workshops were conducted during summer 1999 and winter 2000 to explore these issues.

Possible objectives and criteria for greater emphasis on species-specific management were developed. Criteria involved the population trajectory, the information available for developing models, as well as information for ongoing monitoring, the likelihood that available regulations could be used to control harvest, the value and tradition for harvesting certain stocks. Generally the deficiencies of the databases for greater species-specific emphasis were apparent for many species groups, and the cost of greater harvest-management emphasis usually did not appear to be justified in greater benefits. Among states of the Mississippi Flyway, there was not consistent desire for greater harvest-management emphasis except for mallards, wood ducks, and black ducks (see table attached).

Perceptions of the propriety of species-specific harvest management based on population status(e.g 1995-1999 trend compared to NAWMP goal), existence of adequate information for modeling, likelihood of continued monitoring (feedback), perceptions of value placed on species by hunters', effectiveness of regulations, identification abilities of hunters, availability and utility of specific regulations, tradition for hunting certain species (there could be a tradition for hunting even if not valued), impact of additional species-specific regulation on complexity of regulations, and the overall cost:benefit of more emphasis on regulations (to increase or restrict harvest) for particular species.

Criteria ("+" = favorable, "O" = intermediate or , "--" = unfavorable, V=varies by state, Unk = unknown)	**SPECIES**																	
	Mal	BWT	Pin	Gad	BD	Scp	Can	RH	RN	HM	WD	SG	Ross	WF	EP P	MVP	SJB	GNT
Population trajectory	+	+	--	+	0/--	--	0	0	0	Unk	+	+	+	+	0	0	0/+	+
Information needed for model development - Is the information available?																		
Population (surveys - breeding)	+	O	O	O	+/0	--	O	O	--	--	--	+	+	--	+	+	+	O
Recruitment	O	O	O	O	0	--	--	--	--	--	+/0	+	+	--	+	0	+	+
Mortality / Survival	O	--	O	O	O	--	--	--	--	--	+	+	+	+	+	0	+	+
Harvest rate	O	--	O	O	0	--	--	--	--	--	+	+	+	+	+	--	--	O
Habitat conditions (includes uplands)	O	O	--	O	0	--	O	O	--	--	0	O	O	--	0	0	+	--
Hunter attitudes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	--
Life history characteristics	+	+	+	+	0	O	+	+	O	O	+	+	+	+	+	0	+	+
Information needed for monitoring - Is the information needed for on-going monitoring available?																		
Population survey (breeding ground)	+	O	O	O	+	--	O	O	--	--	--	O	O	--	+	+	+	O
Habitat survey (breeding ground)	O	O	--	O	0	--	O	O	--	--	0/--	O	O	--	--	0	+/0	--
Banding data (rates...)	+	--	O	O	0	--	--	--	--	--	0	+	+	+	O	0	+	O
Measure of recruitment	O	O	O	O	0	--	O	O	O	O	0/--	O	O	--	+	--	+/0	--
Harvest	+	O	O	O	+	O	O	O	O	O	+				--	--	-/0	O
Population distribution (fall / winter)	+	--	+	+	0	--	O	O	--	--	--	+	O	+	0	--	--	--
Hunter perception	--	--	--	--	O	--	--	--	--	--	--	--	--	--	0	--	--	--
Harvest derivations	O	O	O	O	0	--	--	--	--	--	0/--	+	+	+	+	0	0	O
Value" placed on a species by hunters(# states)	14	7	11	5	14	6	6	6	5	--	14	3	3	6	13	14	+	+
Degree - regulations have the intended effect	O	O	O	O	--	--	+	O	--	--	0	O	O	+	+	0	0	O
Hunter ability to ID certain species	+	O	--	--	+/0	--	O	--	--	--	+/0	+	O	+	--	--	--	--
Which regulations are available for controlling harvest management?																		
Season length	+	V	--	--	+	--	--	--	--	--	+	+	+	+	+	+	+	+
Season timing	+	V	V	O	+	--	--	--	--	--	+	+	+	+	+	+	+	+
Bag limit	+	O	O	O	+	+	O	O	O	O	V	+	+	+	+	+	+	+
Season within season	NA	O	O	O	+	O	O	O	O	O	0	+	+	+	NA	0	+	NA
Tradition for harvest of a certain species	+	V	V	V	+	V	V	V	V	--	V	+	+	+	+	+	+	+
Regulation simplicity	O	O	O	O	--	O	O	O	O	O	0	+	+	+	--	--	-	+
Cost : Benefit of greater emphasis on a species	+	V	O	--	O	--	O	--	--	--	0	--	--	O	+	0	0	+

AHM for Midcontinent Mallards

This portion of the meeting was dedicated to reviewing AHM for midcontinent mallards, particularly in terms of current model behavior, possible improvements to survival and reproductive sub-models, and the process for updating model weights.

The Annual Life Cycle of Midcontinent Mallards in Perspective *(Steve Hoekman, Scott Mills, David Howerter, James Devries, Joe Ball)*

We used sensitivity analysis of a demographic model of female midcontinent mallards (*Anas platyrhynchos*) to compare the relative importance of vital rates to population dynamics. For each vital rate, we estimated the mean and process variation (biological variation across space and time) for females breeding on ~70 km^2 sites in the Prairie Pothole Region (PPR). We conducted analytic sensitivity analysis to predict the relative influence of management-induced changes in vital rates on the rate of population growth (8) and variance decomposition analysis to assess the proportion of variation in 8 explained by process variation in each vital rate. Analytic sensitivities were highest for nest success and survival of adult females throughout the life cycle; hence, equal absolute changes in these vital rates would be predicted to result in the largest)8 relative to other vital rates. Variance decomposition analysis indicated that breeding season vital rates were highly variable and were driving variation in 8: vital rates explaining the most variation were nest success (45%), survival of adult females during the breeding season (22%), and survival of ducklings (14%). Survival of adult females outside the breeding season was relatively stable and accounted for only 5% of variation in 8. Our analyses suggest that predation on the breeding grounds is the primary proximate factor limiting population growth within the PPR. We suggest that harvest may have a real but relatively small influence on population dynamics, and that the influence of harvest may be masked by large demographic variation on the breeding grounds. Broadening adaptive management to more fully include breeding-ground events may improve predictive models of population dynamics and aid in controlling for breeding-ground variation when assessing population responses to harvest.

Considerations of Closed Seasons, Very Restrictive Package, and Limited Change Between Regulations Packages *(Jeffrey S. Lawrence and Dale D. Humburg)*

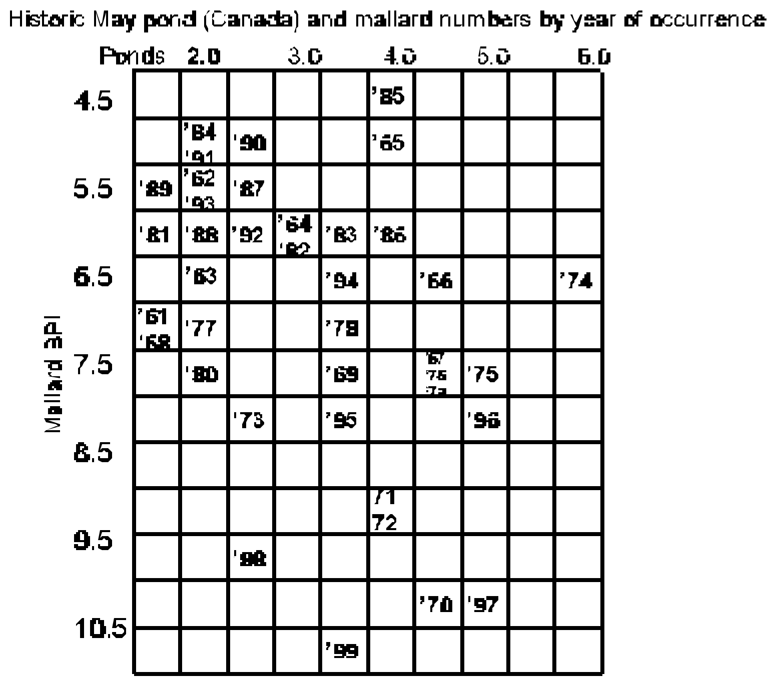
Ideally, under Adaptive Harvest Management, waterfowl managers agree on the harvest management objective(s), models of population dynamics that are periodically updated through monitoring, and regulations alternatives with predicted harvest rates. Once these elements are agreed upon, then they should be prepared to accept the optimal regulatory choices as identified by stochastic optimization (Lubow 1994). This process has provided managers with a better understanding of the linkage between the mathematical description of harvest management objectives and the waterfowl seasons that would be implemented at different levels of mallard populations and pond numbers in the Canadian prairies. Concerns that have arisen from the explicit link between the objective and decision include: (1) if there is much weight on the additive survival models or density-independent recruitment models (Johnson et al. 1997), the optimal harvest strategy recommends closed seasons at population sizes and pond numbers where duck seasons historically were open; and (2) the optimal decision matrix contains narrow bands of intermediate regulations; thus, regulations could change substantially in (e.g. from liberal to restrictive) in consecutive years. In response to the first concern about closed seasons, managers and administrators added another, more restrictive regulations option in 1997 to reduce the probability of selecting a closed season. Issues raised about AHM implementation include: (1) the closed or undefined cells in the optimal decision matrix for mallards; (2) the utility of the very restrictive package; and (3) a constraint limiting change in regulations packages between consecutive duck seasons. We examined how eliminating the closed season and very restrictive package from the suite of regulations packages would influence optimal regulations decisions.

We used Stochastic Dynamic Programming and the 1999 midcontinent mallard model set to calculate optimal harvest strategies for different combinations of regulations packages, model weights, and across a range of harvest rates. We examined the performance of these strategies using Monte Carlo simulations and compared mean breeding population size, harvest, frequency of regulations use, and frequency and magnitude of regulations changes between consecutive years. We also considered historical populations and pond numbers relative to the decision matrix for 1999. Although not entirely a legitimate comparison, because the distribution of optimal decisions would have been affected by past regulatory actions, this provides insights into the degree of potential resource change in the context of regulations.

Excluding the closed season or both the closed and very restrictive regulation alternatives changes the optimal harvest strategy resulted in those decisions being replaced by the most restrictive decision; however, the frequency of the other decisions was unchanged. Thus, the transition points in the matrix from very restrictive to restrictive seasons, restrictive to moderate, and moderate to liberal remained unchanged.

Simulations suggested essentially no difference in breeding population size, harvest, or frequency and change of regulations use when the different sets of regulations alternatives (1999, no closed, no VR, no closed and VR) were included. Infrequent restrictive regulations or closed seasons under these scenarios prompted additional simulations under a range of increasing harvest rates. Similar to initial runs, no change in mean breeding population or harvest and relatively few restrictive seasons occurred until harvest rates increased substantially.

Results of simulations were not consistent with historic experience, in that observed populations and habitat conditions have been more variable than those predicted by simulation. Based on this comparison, more restrictive regulations than simulated appear to be possible, and frequent, large changes in regulations between years seem plausible. Historically, population size has declined to levels in the current closed and very restrictive range, and the infrequent selection of these regulatory alternatives in the simulations may indicate a lack of realism in the models.



We contend that the very-restrictive and closed-season alternatives appear to have little utility in achieving stated goals. Further, a constraint on the process, that would ensure that regulations did not change more than one level between consecutive seasons, was reviewed. While it can be addressed, this is a more difficult programming problem than the previous two items, and will require additional work to understand the possible effects of this constraint. We suggest that managers consider:

(1) eliminating the very restrictive option;
(2) replacing open cells with the "restrictive" option to the level of historic experience with mallard population size (ca. 4.5 million);
(3) further evaluating the influence of year-to-year constraints on regulations increments; and
(4) consider limiting increments of year-to-year change to single regulations "steps."

Models of Survival *(Bill Kendall)*

The survival models in the current AHM model set reflect the competing hypotheses of additive and compensatory mortality. However, there are two basic problems with these models. First, the papers by Burnham et al. (1984) and Smith and Reynolds (1992) (and subsequent analysis by Jim Hines) seem to indicate contradictory results, with the former supporting at least partial compensation and the latter supporting almost complete additivity. However, given that they are based on two different sets of years, this apparent contradiction could indicate that the degree of compensation changes over time. A preliminary analysis by myself that modeled the degree of compensation as period-dependent detected this phenomenon. In that event this type of model becomes undesirable for predictive purposes, because one doesn't know what period one is in.

Secondly, the only mechanism for mortality reflected in the compensation model is hunter kill. Compensation is generally believed to be based on density-dependent mortality due to non-hunting sources. To model compensation in a mechanistic manner, I partition the hunter kill and model the rest of annual mortality [i.e., $S_i = (1 - K_i)\, 2_i$, where S_i is annual survival rate in year i and 2_i is rate of the survival of the non-hunting mortality sources] as a logistic function of density and perhaps other environmental factors.

The latest effort has included estimating the annual estimate of 2_i, accounting for geographic variation in reporting rates based on reward bands to transform recovery rates into kill rates. Because of the complexity of the resulting model, which incorporates reward band data as well, I have only been able to fit the model for banding reference area 4 (NE Southern Alberta and SW Saskatchewan). I then took those estimates of 2_i and plotted them against year and midwinter counts for males. For females I plotted them against year, size of the mallard breeding population in year i+1 ($BPOP_{i+1}$), $BPOP_{i+1}/PONDS_{i+1}$, crop acreage in banding reference area 4 in year i+1, $BPOP_{i+1}*CROPS_{I+1}$, and midwinter counts. None of these plots indicated any discernible pattern. From this information alone there is not much basis for constructing a model that reflects compensation. One could construct a counterpart to the additive model that would predict post-harvest survival as a constant based on the average value of 2_i. This could be made stochastic by using a confidence interval around that average 2_i.

Further work is needed to resolve the programming problems associated with fitting these models, and to match the spatial scale of the candidate predictor variables (e.g., measures of density) with the scale of the banding reference area as closely as possible.

Models of Reproduction *(Jim Dubovsky)*

We continued efforts to develop alternative models of recruitment for the midcontinent population of mallards. The current models for Adaptive Harvest Management (AHM), developed in 1995, include only size of the breeding population in spring and the number of ponds in May in Prairie Canada, and explain less than half of the variation in fall age ratios. We attempted to model the fall age ratios from 1974-95 as functions of additional variables, including total ponds (Prairie Canada and northcentral U.S.) in May, the center of the distribution (latitude and longitude) of the ponds, and an upland habitat variable. We used linear regression and Akaike's Information Criterion (AIC) to identify the 'best' model. The model with the highest R^2 (0.80) and lowest AIC indicated that fall age ratios were negatively related to the size of the spring population, positively related to the number of total ponds in May, and negatively related to the latitude of the pond distribution.

Additionally, we are exploring a philosophically different approach for developing alternative models than that used when AHM was first implemented. In 1995, the best linear model relating fall age ratios to independent variables was developed for inclusion in the AHM model set; the other alternative model was created by refitting the model using the upper 95% confidence value for the population-size coefficient. Thus, the two models were of the same functional form (i.e., linear), and differed only in the values for the parameter estimates. However, results from recent efforts to model recruitment of eastern mallards indicate that optimal harvest strategies can be sensitive to the form (e.g., linear, logistic, logarithmic) of the recruitment models. Therefore, we are attempting to develop the following 3 alternative models that contain the same independent variables (spring population, ponds in May, latitude of ponds), but differ in form: (1) fall age ratios as a linear function of all variables, (2) fall age ratios as a logarithmic function of all variables, and (3) fall age ratios as a reverse logistic function of population size, and as a logarithmic function of ponds in May and latitude. Once the models have been developed, we will explore the implications of incorporating them formally into the AHM model set for midcontinent mallards.

Modeling Wetland Structure in the Prairie Pothole Region *(Andy Royle)*

Knowledge of the spatial distribution of wetlands on the breeding grounds can be important for managing waterfowl because it can help predict reproductive success. This information also can be used to inform models of breeding-pair density, and other relevant attributes of duck populations. Currently, the only measure of "habitat" which informs the harvest management process is estimated pond numbers from the May breeding-population survey. Such broad-scale information is of little use in understanding the spatial distribution of waterfowl (broods or pairs) over the landscape. Moreover, on a small scale, pond estimates are known to be severely biased. Additionally, there is no attempt to quantify physical characteristics of wetland structure such as size and functional regime, both of which are important determinants of wetland use by waterfowl.

We are developing a spatial statistical model which is capable of predicting wetland structure (e.g., numbers, size) at arbitrary spatial scales. Our model uses data from the annual habitat survey conducted by the FWS HAPET office, commonly referred to as the "4 square-mile" survey. The model consists of two components. The first component is a model for the probability of a wetland basin containing water (i.e., *wet probability*), and the second component is a model for the amount of water in a basin (i.e., wet surface area) *conditional* on the basin containing water. Both component models accommodate information on the functional regime of the wetland, it's basin area ("potential wet area"), and spatial correlation among basins.

For modeling the probability that a basin contains water, we assume that observations (1 if a basin contains water, 0 otherwise) follow a Bernoulli distribution with probability π, which is assumed to vary spatially and as a function of basin attributes (size, regime) on the logit scale; i.e.,

$$\text{logit}(\pi_{ij}) \quad \alpha_j \ \sum_{k \ 1}^{p} \beta_k x_{ijk}$$

where π_{ij} is the probability that wetland basin *i* within plot *j* contains water, x_{ijk} is the value of predictor variable *k* for basin *ij* (e.g., size, regime), β_k are the corresponding regression coefficients, and α_j are random plot effects, assumed to be spatially correlated with correlation function $\text{Corr}(\alpha_j, \alpha_{j'}) \quad k_\theta(d(j, j'))$. Thus, this model is a version of the standard logistic regression model, but with both fixed and random factors (i.e., a "mixed model"). Similar model structure is assumed for the wet surface area model, but with a log-normal distributional assumption instead of Bernoulli.

Model fitting and prediction are carried out using a procedure known as Markov Chain Monte Carlo. The resulting basin-specific predictions may then be aggregated to whatever suitable spatial resolution is desired, thus producing a map of the spatial distribution of water over the landscape.

Updating Model Weights *(Bill Kendall)*

The history of model weights since the AHM process began in 1995 included a shift to greatly favor additive mortality, almost to the exclusion of compensatory mortality. The direction of this shift was not surprising, given the latest data on survival at that point in time. Moreover, the severity of the shift was not surprising when the distribution of predicted values for BPOPs in 1996 was examined for each model. Although the observed BPOP in 1996 was lower than the average prediction for any of the four models, it was close to the average for the two additive-mortality models and far out in the tail of the distribution for the compensatory mortality models. The case was similar in 1998. Although the BPOP in 1997 favored compensatory mortality, the result was not as extreme as in 1996 and 1998, and therefore the weights for compensation remained close to 0. In 1999, results again favored compensation and this time the weight on compensation, although still small, increased by a couple of orders of magnitude. If the result for 2000 is similar to 1999, the weights will shift dramatically toward the compensatory models. The current weights remain an accumulation of information over four years based on Bayesian inference. The order in which the results occurred is irrelevant.

The ability to shift so severely from one model to another is a reflection of the limited sources of uncertainty that are included in the distribution predicted BPOPs under each model. These include sampling variation in BPOP and the number of ponds from the May Survey (partial observability), and either the sampling variation in observed harvest rates (1996), or variation in the prediction of harvest rates under each package (1997-99, partial controllability). These are consistent with, and even exceed the sources of uncertainty incorporated in the optimization of midcontinent-mallard harvest based on the SDP optimization software. Neither of these approaches includes things such as the error of the regression that produced the weakly density-dependent recruitment model, or the uncertainty in the estimate of survival in the absence of hunting for the survival models. Under the current model set, and given that the strongly density-dependent recruitment model and the compensatory mortality model are based on fixing parameters (i.e., not estimating them), it has not been clear how best to incorporate additional uncertainty. This question overlaps with the more general question of how to incorporate uncertainty in the model set as a whole.

Between now and the winter flyway meetings we will address how to best incorporate uncertainty under the current model set, concurrent with an effort to review the entire model set. The two are very much related. This certainly will involve incorporating more uncertainty into the process and, therefore, will result in a process where weights change more slowly. In the meantime, the process remains unbiased and so far the model set as a whole has done a good job of predicting the last four BPOPs.

Reward-banding *(Jim Dubovsky)*

Historically, the reporting rate (i.e., the proportion of bands from hunter-shot birds reported to the Bird Banding Laboratory [BBL]) of bands from mallards has been low. To improve the efficiency of the waterfowl banding program, Federal, Provincial, and State agencies devised a strategic plan to increase reporting rates. The plan was comprised of the following 3 phases: (1) assessment of contemporary reporting rates of standard (AVISE) bands, (2) alter band inscriptions (inscribe a more complete address for the BBL, and later a toll-free telephone number by which hunters could report bands), and (3) assess the reporting rates of bands with the new inscriptions. The first phase was conducted in the late 1980s, and indicated average reporting rates of 0.32-0.38 for AVISE bands placed on mallards (Nichols et al. 1991, Nichols et al. 1995). Beginning in 1993, bands with the more complete address were placed on mallards; in 1995 bands with the toll-free number were first put on mallards, and complete-address bands were phased out in favor of the toll-free bands. Initial estimates for reporting rates for complete-address and toll-free bands were 0.50 and 0.62, respectively, for the 1993-95 hunting seasons. Following these initial efforts, several years were allowed to elapse to permit any change in reporting rates that may have occurred due to the conversion to toll-free bands to stabilize. In 1998, a reward-band pilot study was initiated to assess whether reporting rates of the toll-free numbers had stabilized. Several thousand reward and control bands were placed on adult male mallards in southern Saskatchewan. The study was continued in 1999. Results of preliminary analyses suggest that reporting rates of toll-free bands may have stabilized. The best-fitting model included a constant reporting rate (0.84) for the 1998-99 and 1999-2000 hunting seasons. However, a model that fit the data nearly as well suggested that reporting rates varied by season (0.80 and 0.86 for the1998-99 and 1999-2000 seasons, respectively). The pilot study will continue for the 2000-01 hunting season. Also during the next year, the study design for a more large-scale reward-bard study will be refined. This expanded study will include a banded sample of mallards (both male and female) from a larger geographic area, as well as inclusion of other species (e.g., black ducks, wood ducks, Canada geese).

AHM for Midcontinent Mallards: Discussion

The following issues and action items were discussed at the conclusion of the session on midcontinent mallards:

(1) *Reward banding:* Mike Johnson is chairing a special session on banding at the upcoming Joint Flyway Council meeting in Memphis. Mike will organize an agenda dealing with study designs, as well as Bird Banding Laboratory and funding issues.

(2) *Frequency of restrictive hunting seasons:* Simulations depicting an absence of low population levels and associated prescriptions for closed and very restrictive seasons do not seem realistic given the historical record of mallard abundance. These simulations suggest possible problems with model structure, or with the magnitude of process variance for which the models account. Therefore, no further simulation work of this nature will be conducted until after the model set has been revised. In the meantime, the Flyway Councils may consider recommending elimination of the very restrictive option because of its apparent low utility.

(3) *Survival models:* Bill Kendall will continue to pursue a more mechanistic model of compensatory mortality. Bill now has an assistant to help with the analyses, and hopes to demonstrate substantive progress by next year.

(4) *Reproductive models:* Jim Dubovsky will explore different functional forms for reproduction and develop a set of alternative models for consideration. The results of these investigations will be shared with the Flyway Council Technical Sections in February and March, 2001.

(5) *Model weights:* There is an agreed-upon need to account for all process variation in the updating procedure, whether or not that variation is explained by the models. This will be more straightforward once the model set for mallards has been revised. The inclusion of additional variance components in the updating procedure likely will slow the movement of model weights, and perhaps be more reflective of actual rates of learning.

Patterns of Duck Harvest: Proportional Distribution and Hunter Success *(Bob Raftovich, Jerry Serie, Fred Johnson, Woody Martin, Paul Padding)*

The purpose of this project was to determine whether temporal changes in duck harvest distribution have occurred among and within Flyways and to determine patterns of seasonal success among and within Flyways. Since the early 60's many changes have occurred in duck abundance, habitat conditions, hunter numbers, and hunting regulations, yet we have little insight into Flyway and regional patterns of duck harvest and hunter success.

Data were obtained from the MBMO Harvest Surveys Section to calculate the proportion of U.S. harvest that occurred in each flyway, and the proportion of flyway harvest that occurred in each of 3 latitudinal regions within the flyway (Table 1). Hunter success (average seasonal bag, or ducks killed per active adult hunter) for each flyway and for the regions within each flyway also were calculated. Data organization and calculations were done with SAS and Excel. Proportional harvest and hunter success, along with season lengths, for each flyway were plotted as figures.

Proportional duck harvest among flyways showed a gradual long-term increase in the Mississippi and a gradual long-term decrease in the Pacific Flyway. No long-term changes in the Atlantic or Central Flyways were apparent. Harvest distribution within Flyways remained relatively stable during the 1970s and 1980s despite major changes in duck abundance, hunter numbers, and hunting regulations. However, since 1995 the proportion of the harvest in the southern regions of the Atlantic and Mississippi Flyways seems to have increased, while the northern region decreased. Proportion of the harvest in the mid-latitude regions of all Flyways appeared to be relatively stable over time.

Hunter success has improved generally in all Flyways since 1995 and exceeds success during the 1970s. Within all Flyways, hunter success is higher in the Southern Regions. Hunter success in the southern region of all Flyways seems to track duck abundance, hunting regulations, or both better than in the northern or mid-latitude regions. Hunter success in all regions increased after 1995. In conclusion, patterns of proportional duck harvest and hunter success seem to have changed markedly within Flyways in recent years. Causal factors are not clear, but more liberal hunting regulations since 1995 and changes in hunter success rates may be involved. Additional work is needed to further clarify the nature of these relationships.

Table 1. Grouping of states into regions by flyway.

Latitude region	Flyway			
	Pacific	Central	Mississippi	Atlantic
Northern	Washington Oregon Idaho Montana[a] Wyoming[a]	North Dakota South Dakota Montana[a] Wyoming[a]	Minnesota Wisconsin Michigan	Maine Vermont New Hampshire Massachuesetts Connecticut Rhode Island New York
Mid-latitude	Nevada Utah Colorado[a]	Kansas Nebraska Colorado[a]	Iowa Illinois Indiana Ohio Missouri Kentucky	Pennsylvania New Jersey Delaware Maryland Virginia West Virginia

Southern	California Arizona New Mexico[a]	Oklahoma Texas New Mexico[a]	Alabama Arkansas Tennessee Louisiana Mississippi	North Carolina South Carolina Georgia Florida

[a] State split between the Pacific and Central Flyways.

AHM and Considerations of Hunter Preferences *(Dale Humburg)*

Among issues discussed during the 1999 and 2000 AHM Working Group meetings was the process of setting management goals and objectives. There continue to be unresolved value judgements among stakeholders about how to value harvest benefits and how those benefits should be shared. Although consequences of management actions on mallard harvests have been explicitly incorporated into AHM, management goals that have not been clearly defined include elements of "what hunters want." Explicit inclusion of hunter satisfaction would integrate information and justification / rationale for harvest-management decisions that currently are not considered.

Ringelman (1997) provided a baseline for comparison and initial standards for hunter expectations for harvest management. A systematic process for determining hunters' views would be needed if future management decisions were to include consideration of hunter preferences.

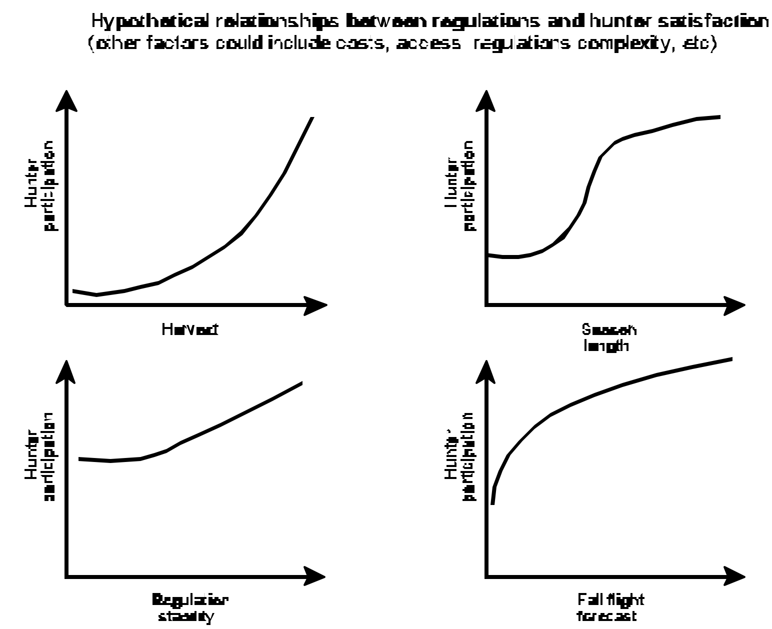
A recommendation to consider incorporating measures of hunter preference and satisfaction into waterfowl harvest management led to a survey of flyway states to determine the level of potential interest. Most technical-group and Council members believed hunter information was important and most also relied on related information when developing harvest regulations (see attached survey results). Less than half of respondents, however, reported annually or periodically conducting hunter opinion surveys. Letters from hunters, personal experience, and public meetings were at least as important as survey information. Although applicable for state-specific decisions, these sources of hunter opinion are not sufficient for nationwide decisions involving hunter satisfaction. Nearly all respondents indicated a desire to participate in a nationwide survey of hunter preferences.

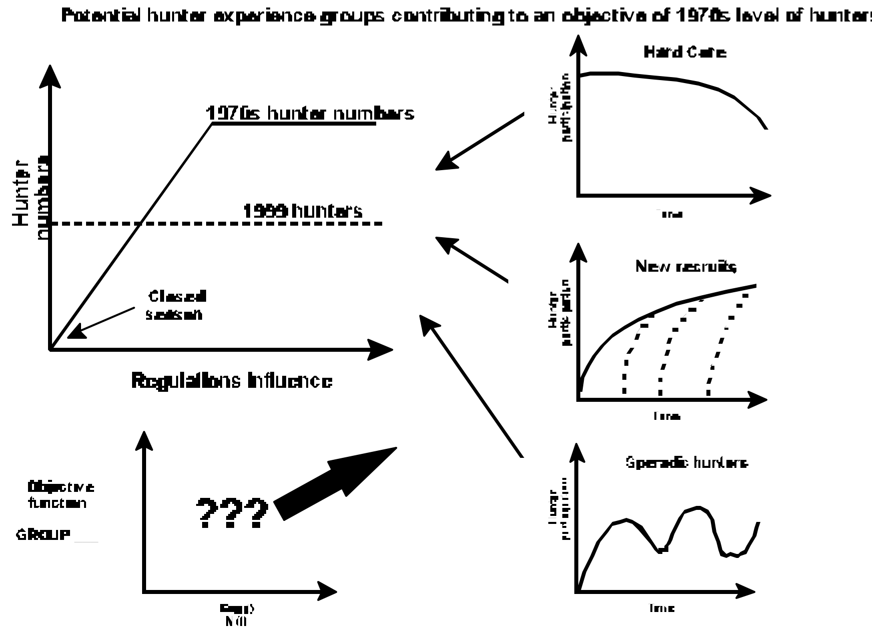
Despite agreement on the need for hunter-opinion data, the specific use and application of this information is not clear. A workshop during the May 2000 AHM Working Group meeting was designed to further explore how information about hunter satisfaction would be used. Dave Case, as introduction to the workshop, suggested that a primary purpose of waterfowl regulations and harvest management is related to hunter satisfaction.

Small groups discussed how (and whether) to incorporate measures of hunter satisfaction into the AHM process. The framework for discussion involved specific descriptions of perceptions about hunter dynamics and attitudes, objectives for hunter numbers and satisfaction, disagreements about factors affecting hunter satisfaction, possible regulations alternatives affecting hunters, and methods of information feedback. A disparity of opinion about the role of the AHM Working Group regarding hunter opinions in harvest management was apparent in the extreme view, "it's a State problem," and intractable from the standpoint of AHM.

The basic assumption implied in the AHM objective of maximum long-term harvest is that hunters want to harvest as many ducks as possible. If hunter satisfaction is related to measures other than harvest (e.g., opportunity, regulations stability), the objective to maximize harvest may not capture some primary motivations for hunting. Current uncertainties about hunter dynamics involve response to specific regulations features. Concerns about the complexity of a joint optimization and the feedback necessary to inform the process led to additional questions about the propriety of explicitly including measures of hunter satisfaction into AHM.

Achieving and maintaining 1970s levels of U.S. duck hunters was cited as a possible objective. However, hunter motivations and age/experience groups were cited as key pieces of information that generally are lacking. The proportions of hunters that are influenced by achievement, affiliative, or appreciative factors were described by Ringelman (1996); however, ongoing monitoring of how these groups change largely is nonexistent. Maintaining hunter numbers likely would require knowledge of the demographics of various groups, their motivations, and how regulations affect each group differentially.





The need for additional human-dimensions expertise is evident if measures other than simple hunter numbers are needed. Other concerns included the dynamic nature and geographic variation in hunter opinions, biased perceptions of hunter attitudes, agency influence on hunter perception, the degree to which resource management and hunting management are related, and which methods in addition to mail surveys should be considered.

As a result of AHM Working Group discussions, questions arose about whether technical people and policy makers and state and federal biologists agree on objectives and the degree to which hunter satisfaction should be considered. Prior to surveying hunters about their opinions, state and federal biologists and administrators need to clarify their views about the fundamental objective of waterfowl harvest management (not necessarily AHM).

Two recommendations were discussed in this regard: (1) advance understanding of regional differences in harvest and opportunity metrics; and (2) consider facilitated focus groups among technicians and administrators (Councils and SRC) to explore expectations related to regulations effects on hunter response versus duck-population response. A subcommittee (Humburg, Padding, Moore, Gammonley, Serie, Case, Kraege, and Swift) will meet during the summer joint Flyway Council meeting to further develop the schedule and nature of these recommendations.

<u>Coordinated Waterfowl Hunter Surveys</u>: One recommendation from the Adaptive Harvest Management Working Group in Spring 1999 was to explore the need, feasibility, and interest in coordinated surveys of waterfowl hunter opinion about regulations. This effort(s) would be a follow-up to the survey coordinated by Jim Ringelman in 1996, which corresponded to the period when current regulations packages were developed for AHM.

Forty-four Council members completed the following survey to provide information about the level of interest in hunter information surveys and the degree to which this type of information is needed.

1. Indicate how much you rely on hunter opinion when waterfowl regulations are developed in your state (check one). (n=42)

Greatly	Somewhat	Not much	Don't know
17 (40.5%)	21 (50.0%)	4 (9.5%)	0

2. Indicate how much you believe information on hunter attitudes is needed when waterfowl regulations are developed in your state (check one). (n=42)

Greatly	Somewhat	Not much	Don't know
23 (54.8%)	17 (40.5%)	2 (4.8%)	0

3. Indicate the frequency with which waterfowl hunter opinion surveys are conducted in your state (check one). (n=41)

Annually	Periodically	Infrequently	Never
7 (17.1%)	14 (34.1%)	18 (43.9%)	2 (4.9%)

4. Indicate which sources of hunter opinion information you use most to develop waterfowl hunting regulations (check those used most).

Information Source	Greatly	Somewhat	Not much	Don't know
Attitude surveys (n=40)	9 (22.5%)	15 (37.5%)	16 (40.0%)	0
Telephone contacts (n=40)	3 (7.5%)	19 (47.5%)	18 (45.0%)	0
Letters / email (n=41)	5 (12.2%)	26 (63.4%)	10 (24.4%)	0
Personal experience (n=40)	10 (25.0%)	22 (55.0%)	8 (20.0%)	0
Public meetings (n=41)	14 (34.1%)	20 (48.8%)	7 (17.1%)	0

5. Would your state participate in coordinated surveys of waterfowl hunter opinion? (n=40)

   39 (97.5%) Yes 1 (2.5%) No

6. If not, indicate which of the following would limit your participation (check all that apply). (n=15)

   11 (73.3%) Funding 0 Legal constraints 0 Level of interest 4 (26.7%) other

7. If coordinated surveys are conducted, how frequently do you believe they would be needed? (Check one) (n=41)

   3 (7.3%) Annually 25 (61.0%) Every few years 13 (31.7%) Based on need

Forty-seven Technical Section members also responded to the survey:

1. Indicate how much you rely on hunter opinion when waterfowl regulations are developed in your state (check one). (n=45)

Greatly	Somewhat	Not much	Don’t know
15 (33.3%)	26 (57.8%)	4 (8.9%)	0

2. Indicate how much you believe information on hunter attitudes is needed when waterfowl regulations are developed in your state (check one). (n=46)

Greatly	Somewhat	Not much	Don’t know
28 (60.9%)	18 (39.1%)	0	0

3. Indicate the frequency with which waterfowl hunter opinion surveys are conducted in your state (check one). (n=46)

Annually	Periodically	Infrequently	Never
2 (4.3%)	12 (26.1%)	28 (60.9%)	4 (8.7%)

4. Indicate which sources of hunter opinion information you use most to develop waterfowl hunting regulations (check those used most).

	Greatly	Somewhat	Not much	Don’t know
Attitude surveys (n=43)	12 (27.9%)	13 (30.2%)	16 (37.2%)	2 (4.7%)
Telephone contacts (n=42)	6 (14.3%)	22 (52.4%)	13 (31.0%)	1 (2.4%)
Letters / email (n=43)	5 (11.6%)	24 (55.8%)	13 (30.2%)	1 (2.3%)
Personal experience (n=43)	10 (23.3%)	24 (55.8%)	9 (20.9%)	0
Public meetings (n=45)	20 (44.4%)	15 (33.3%)	10 (22.2%)	0

5. Would your state participate in coordinated surveys of waterfowl hunter opinion? (n=41)

39 (95.1%) Yes   2 (4.9%) No

6. If not, indicate which of the following would limit your participation (check all that apply). (n=15)

13 (86.7%) Funding   0 Legal constraints   2 (13.3%) Level of interest   0 other

7. If coordinated surveys are conducted, how frequently do you believe they would be needed? (Check one) (n=47)

2 (4.3%) Annually   21 (44.7%) Every few years   24 (51.1%) Based on need

Responses by Flyway Council and technical groups combined [Atlantic Flyway (n=32); Mississippi Flyway (n=36); Central Flyway (n=16); Pacific Flyway (n=17)]:

1. Indicate how much you rely on hunter opinion when waterfowl regulations are developed in your state (check one).

Greatly	Somewhat	Not much	Don’t know

Atlantic (n=31)	10 (32.3%)	19 (61.3%)	2 (6.5%)	0
Mississippi (n=35)	20 (57.1%)	14 (40.0%)	1 (2.9%)	0
Central (n=14)	4 (28.6%)	8 (57.1%)	2 (14.3%)	0
Pacific (n=17)	2 (11.8%)	12 (70.6%)	3 (17.6%)	0

2. Indicate how much you believe information on hunter attitudes is needed when waterfowl regulations are developed in your state (check one).

	Greatly	Somewhat	Not much	Don’t know
Atlantic (n=31)	20 (64.5%)	11 (35.5%)	0	0
Mississippi (n=36)	27 (75.0%)	9 (25.0%)	0	0
Central (n=15)	7 (46.7%)	6 (40.0%)	2 (13.3%)	0
Pacific (n=16)	5 (31.3%)	11 (68.8%)	0	0

3. Indicate the frequency with which waterfowl hunter opinion surveys are conducted in your state (check one).

	Annually	Periodically	Infrequently	Never
Atlantic (n=31)	1 (3.2%)	8 (25.8%)	19 (61.3%)	3 (9.7%)
Mississippi (n=34)	9 (26.5%)	10 (29.4%)	14 (41.2%)	1 (2.9%)
Central (n=15)	2 (13.3%)	6 (40.0%)	6 (40.0%)	1 (6.7%)
Pacific (n=17)	0	4 (23.5%)	12 (70.6%)	1 (5.9%)

4. Indicate which sources of hunter opinion information you use most to develop waterfowl hunting regulations (check those used most).

Attitude Surveys

	Greatly	Somewhat	Not much	Don’t know
Atlantic (n=30)	7 (23.3%)	8 (26.7%)	14 (46.7%)	1 (3.3%)
Mississippi (n=36)	11 (30.6%)	11 (30.6%)	14 (38.9%)	0
Central (n=13)	4 (30.8%)	4 (30.8%)	5 (38.5%)	0
Pacific (n=14)	1 (7.1%)	8 (57.1%)	4 (28.6%)	1 (7.1%)

Telephone Contacts

	Greatly	Somewhat	Not much	Don’t know
Atlantic (n=29)	4 (13.8%)	17 (58.6%)	7 (24.1%)	1 (3.4%)

Mississippi (n=36)	4 (11.1%)	26 (72.2%)	6 (16.7%)	0
Central (n=13)	1 (7.7%)	4 (30.8%)	8 (61.5%)	0
Pacific (n=14)	1 (7.1%)	2 (14.3%)	11 (78.6%)	0

Letters / email

	Greatly	Somewhat	Not much	Don't know
Atlantic (n=30)	5 (16.7%)	16 (53.3%)	9 (30.0%)	0
Mississippi (n=36)	4 (11.1%)	26 (72.2%)	5 (13.9%)	1 (2.8%)
Central (n=14)	0	10 (71.4%)	4 (28.6%)	0
Pacific (n=13)	3 (23.1%)	4 (30.8%)	6 (46.2%)	0

Personal experience

	Greatly	Somewhat	Not much	Don't know
Atlantic (n=28)	8 (28.6%)	13 (46.4%)	7 (25.0%)	0
Mississippi (n=34)	10 (29.4%)	18 (52.9%)	6 (17.6%)	0
Central (n=15)	3 (20.0%)	9 (60.0%)	3 (20.0%)	0
Pacific (n=16)	3 (18.8%)	10 (62.5%)	3 (18.8%)	0

Public meetings

	Greatly	Somewhat	Not much	Don't know
Atlantic (n=30)	21 (70.0%)	8 (26.7%)	1 (3.3%)	0
Mississippi (n=36)	9 (25.0%)	19 (52.8%)	8 (22.2%)	0
Central (n=13)	2 (15.4%)	6 (46.2%)	5 (38.5%)	0
Pacific (n=17)	5 (29.4%)	8 (47.1%)	4 (23.5%)	0

5. Would your state participate in coordinated surveys of waterfowl hunter opinion?

	Yes	No
Atlantic (n=28)	26 (92.9%)	2 (7.1%)
Mississippi (n=33)	33 (100.0%)	0
Central (n=13)	12 (92.3%)	1 (7.7%)
Pacific (n=15)	14 (93.3%)	1 (6.7%)

6. If not, indicate which of the following would limit your participation (check all that apply).

	Funding	Legal constraints	Level of interest	other
Atlantic (n=14)	12 (85.7%)	0	0	2 (14.3%)
Mississippi (n=7)	6 (85.7%)	0	0	1 (14.3%)

Central (n=7)	3 (42.9%)	0	2 (28.6%)	2 (28.6%)
Pacific (n=3)	3 (100.0%)	0	0	0

7. If coordinated surveys are conducted, how frequently do you believe they would be needed? (Check one)

	Annually	Every few years	Based on need
Atlantic (n=31)	1 (3.2%)	16 (51.6%)	14 (45.2%)
Mississippi (n=35)	4 (11.4%)	20 (57.1%)	11 (31.4%)
Central (n=15)	1 (6.7%)	7 (46.7%)	7 (46.7%)
Pacific (n=17)	0	10 (58.8%)	7 (41.2%)

Communication Team Report *(Dave Case, Dave Sharpe, Mike Johnson, Dan Yparraguire, Dale Humburg, Brian Swift, and Fred Johnson)*

Goal and Objectives: The group reviewed the goal and objectives of the 1999 Communications Strategy and agreed these were still on track.

Issues: The group then discussed the issues identified in the 1999 Strategy and those added to the strategy during our communications earlier in the week. Most of the discussion focused on the issue:

> "Widening gap in expertise and understanding on technical issues (statistics, modeling, etc.) between various internal audiences–even biologists"

The group discussed and agreed that AHM may be blamed for resulting in both too liberal and too conservative regulations.

Key Messages: The group didn't review the key messages. However, they emphasized the importance of communicating the message that:

> "AHM is a process, not an event. We are in the beginning of that process. It's a process that never ends."

Recommended Actions: The following recommended actions were developed for consideration by the full Working Group:

(1) Hold a "refresher" workshop on AHM. Three days in December. Mainly for AHM working group, but other technical folks would be invited.

(2) Develop 1-day and 2-hour team-taught courses. Use a SWAT-team approach. Develop course work and applications that could be presented on the Internet.

(3) Make presentation to Flyway Councils in July. Dale Humburg will be organizing this session, which might include the history of waterfowl management, AHM as currently practiced, and remaining challenges. Possible presenters include Fred Johnson, Dale Humburg, Dave Anderson, Jim Nichols, and Ken Williams. This session must be coordinated with the concurrent SRC session.

(4) Add an AHM review to the beginning of each AHM Working Group meeting.

(5) Develop the harvest distribution analysis work that Jerry Serie and Bob Raftovich presented into a communications product for technical audiences. This will require some additional analysis. Ask Paul Padding if Mary Moore could help out from a statistical standpoint.

Implications of Steve Hoekman's talk: The group concluded the meeting by discussing Steve Hoekman's talk concerning the need to better explain the role of hunting versus other factors on waterfowl populations.

- This is a message that has to be included in communications plan
- Originally designed for hunter audiences
- Need to make it a positive story–it's a big story

Meeting Action Items

Communications:

(1) There will be a 2-3 day refresher course in AHM held during the week of December 4, 2000. Location will be announced later. Attendance will be limited to Working Group members and invited guests (about 30 total).

(2) The Working Group will develop both a 1-day and 2-hour AHM course that can be taught by designated individuals when and where needed.

(3) Several Working Group members will make presentations at the upcoming Joint Flyway Council Meeting in Memphis. A key session of interest will be on AHM on Thursday, July 27th.

(4) There will be a brief review of the principles and practice of AHM at the beginning of each Working Group meeting to acquaint new participants with the process.

(5) Jerry Serie, Dale Humburg, and others will develop the material presented on harvest distribution for dissemination to technical audiences.

Modeling Issues:

(1) *Use of male versus female harvest age ratios for indexing production:* There does not appear to be any definitive answer to the question of whether male or female age ratios provide the most reliable index to temporal patterns of reproduction. However, modelers are advised to consider the issue carefully in their particular applications, and to have good rationale for their choice.

(2) *Bias in estimated survival and reproductive rates:* Comparisons of observed patterns of duck abundance with predictions based on survival and reproduction rates suggests that estimated vital rates may be positively biased. Paul Padding, Bill Kendall, and Jim Dubovsky agreed to investigate the issue further, focusing initially on reproductive rates. Mark Otto and Mike Conroy also agreed to investigate the modeling of observed time-series of abundances to better understand the nature of the potential bias.

(3) *Optimal harvests and functional forms:* Modelers are advised to consider carefully the effects of functional form on model behaviors and resulting harvest policies. Emphasis should be placed on functional forms that can be supported by ecological theory.

(4) *Mechanistic versus phenomenological survival models:* Bill Kendall, Mike Runge, Sue Sheaffer, and Mike Conroy agreed to explore the utility of more mechanistic models (i.e., those that provide a density-dependent mechanism for harvest compensation).

(5) *Temporal effects of covariates:* Modelers need to be aware that the effects of predictor variables can change over time, and that this may be particularly evident in relatively long time series (i.e., >20 years). Failure to account for these temporal changes can severely bias optimal harvest strategies.

(6) *Sex ratio of breeding populations:* The sex ratio of breeding populations typically cannot be observed directly, and must be inferred from other sources of information. Mike Runge, Fred Johnson, and Mark Otto agreed to investigate the sensitivity of optimal harvest strategies to uncertain sex ratios, and to explore the capability to make robust decisions in the face of this uncertainty.

AHM for Pintails:

Mike Runge will work with the Pacific Flyway and others to finalize the set of alternative models by January 2001. The Pacific Flyway Study Committee will assume responsibility to modeling the relationship between hunting regulations and harvest or harvest rate. Soon a decision will be necessary regarding whether: (a) mallard and pintail hunting regulations should be optimized jointly (i.e., the choice of regulatory alternative would be conditioned on both the status of midcontinent mallards and pintails; (b) mallard and pintail seasons are made independent (i.e., separate optimization process for each); or (c) pintail bag limits (or other regulatory tools) are conditioned on the choice of regulatory alternatives prescribed for midcontinent mallards.

AHM for Western Mallards:

Fred Johnson will take the lead for integration of western mallards once a final model set is agreed upon. The Pacific Flyway should appoint someone to work with Fred on these analyses. The Pacific Flyway Study Committee has the responsibility for following up the modeling work of Sue Sheaffer, and for recommending a final model set.

Revision to the set of regulatory alternatives:

The Working Group would like to consider a fixed schedule for making revisions to the set of regulatory alternatives. Mike Johnson and the Central Flyway will take the lead in asking the Flyway Councils to consider criteria governing periodic regulatory changes. The Working Group will consider any recommendations from the Flyway Councils during their meeting in April, 2001.

Next AHM Working Group meeting:

The next meeting will be held April 10-13, 2001. The Pacific Flyway will consider hosting the meeting on the West Coast because of the emerging focus on pintails and western mallards.